Neutrino Oscillations vs Charged-Lepton Oscillations

Question: Why don't we see $\mu \rightarrow e$ oscillations?

(Note: $\mu \rightarrow e$ oscillations would be very rapid due to their large Δm^2)

Neutrino Oscillations vs Charged-Lepton Oscillations

Question: Why don't we see $\mu \rightarrow e$ oscillations?

(Note: $\mu \rightarrow e$ oscillations would be very rapid due to their large Δm^2)

Answer: Neutrinos are identified by their flavors, while charge leptons are identified by their mass!

Neutrinos are identified by their flavor!

$$\nu_e = \cos\theta\, \nu_1 + \sin\theta\, \nu_2$$
$$\nu_\mu = -\sin\theta\, \nu_1 + \cos\theta\, \nu_2$$

Useful!

$$\nu_1 = \cos\theta\, \nu_e - \sin\theta\, \nu_\mu$$
$$\nu_2 = \sin\theta\, \nu_e + \cos\theta\, \nu_\mu$$

Not Useful!

When we measure neutrinos in oscillation experiments, we are insensitive to their mass; however, we are very sensitive to their flavor!

Charged Leptons are identified by their mass!

$$l_\alpha = \cos\theta\, l_1 + \sin\theta\, l_2$$
$$l_\beta = -\sin\theta\, l_1 + \cos\theta\, l_2$$

Not Useful!

$$e = l_1 = \cos\theta\, l_\alpha - \sin\theta\, l_\beta$$
$$\mu = l_2 = \sin\theta\, l_\alpha + \cos\theta\, l_\beta$$

Useful!

When we measure charged leptons, we are insensitive to their flavor; however, we are very sensitive to their mass!

Neutrinos Won't Oscillate if their Masses are Fixed!

Consider $\pi^+ \to \mu^+ \nu_\mu$

I. If the μ^+ is unmeasured => $\nu_\mu = -\sin\theta\, \nu_1 + \cos\theta\, \nu_2$

Neutrino Oscillations!

II. If the μ^+ is measured so precisely that the ν_μ mass is known =>

$\nu_2 = \sin\theta\, \nu_e + \cos\theta\, \nu_\mu$ No Neutrino Oscillations!